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# CHAPTER FOURTEEN

# METAMEMORY

Much of how our memories affect thinking and behavior occurs out of conscious awareness. Still, we do have conscious insights. There are instances in which we are very much aware of our efforts to remember and, more painfully, instances when we fail to do so. To remember effectively, we need some conscious awareness and control of our own memories. This is **metamemory**—the awareness of one's own memory. This refers to both the contents of memory as well as how to control it. There are a number of ways to look at metamemory. First, we examine theories of metamemory, and then we look at a number of phenomena, including our ability to judge when we have learned something or whether we will later remember things that are currently forgotten. We also look at how we know that we *don't* know something. After this we look at issues involved in the phenomenology of memory, such as the experience of an act of remembering, and how what we currently know biases what we remember of the past. After this we address the monitoring and control of one's own memory with prospective memory, which is remembering to do things in the future, and directed forgetting. Finally, we look at how to use what we know about our own memory to improve it, including the use of mnemonics and some people who have exceptional memories.

## GENERAL PROPERTIES AND THEORIES OF METAMEMORY

Before addressing various aspects of metamemory, let's go over the difference between cues and targets. Then we'll look at some theories on how metamemory judgments are made—namely, the cue familiarity, accessibility, and competition hypotheses.

### Cues and Targets

As a point of terminology, the memory traces that people make judgments about are called *targets*, and the questions or prompts are called *cues*. So, if someone were to ask you if you remember your 13th birthday, the memory for the birthday would be the target, and the question would be the cue.

In his review of metamemory, Schwartz (1994) outlined two types of information that are used to make judgments. Target-based sources are information from the memory trace about which the judgment is made, including information retrieved from memory, as well as the ease with which it is recovered. Target-based sources are especially important in judgments of learning. In comparison, cue-based sources are information gleaned from a memory cue, such as a question. Metamemory judgments are better in proportion to the familiarity of the cue information. For example, if someone asks you a question about a topic you are relatively familiar with, you are more inclined to say that you know the answer based on how familiar the information in the question is. Now, let's look at three general theories of metamemory.

### Cue Familiarity Hypothesis

According to the **cue familiarity hypothesis** (Metcalfe, 2000; Reder, 1987), metamemory judgments are based on the familiarity of the information in a cue. The more familiar it is, the more likely people will judge that the knowledge is in memory. Imagine if someone asked you if you know your grandmother's maiden name. If you know a lot about your family, you might recognize this as a familiar topic and say to yourself, "This is something I know." However, if you are not all wrapped up in your family's history, you might recognize this as a topic you know little about and say to yourself, "I have no clue."

### Accessibility Hypothesis

According to the **accessibility hypothesis** (Koriat, 1993, 1995), people infer what is in memory based on information at hand, including partial retrievals. Two sources of information are used to make these inferences. One is the amount of information activated when a judgment is made. The more that is activated, the more likely that the information is known. For example, if you can't think of someone's name, but you know what letter it begins with, how many syllables it has, and so on, then that is a lot of information, and you judge that the name is in memory. The other source of information is the intensity of the activated memory traces, including the ease of access, how specific the information is, and so on. The stronger the retrieved information, the more likely the knowledge is in memory. For example, if you are asked what your best friend's mother's maiden name was, a number of names might be activated in memory, but only very weakly. As a result, you decide that you do not know that. Comparing the cue familiarity and accessibility hypotheses, the first is more apt for metamemory decisions are made under time pressure; otherwise the second is more appropriate (Benjamin, 2005; Metcalfe & Finn, 2008b).

### Competition Hypothesis

According to the **competition hypothesis** (Schreiber, 1998; Schreiber & Nelson, 1998), metamemory judgments are influenced by the number of memory trace competitors involved in retrieval. Metamemory judgments are greater with less competition. When only a few traces are involved, people can assume that the search process is fairly targeted and is likely to produce the desired information. In contrast, if a large number of traces are involved, then it is less likely that the knowledge is going to be retrieved. The more competition among the relevant traces, the more difficult retrieval will be.

### Synopsis

There are a number of theories of metamemory. They suggest that decisions are based on the familiarity of the cues, on a partial memory search, or on how much interference is experienced.

## KNOWING WHAT IS KNOWN

The first type of metamemory we tackle is how well people know their own memories, including assessments of how well information has been learned, whether information that has been forgotten is still known, and how we know that we don't know something.

### Judgments of Learning

When learning, it is helpful to know how well new information is stored in memory. Information that is poorly learned should be studied more, and information that is well learned does not need much further study. Estimates people make for how well they have learned something are called **judgments of learning** (JOLs) (Arbuckle & Cuddy, 1969). Studies of JOLs have shown that they are between poor and horrible assessments of how much has actually been learned. The question is, why?

**Theories of JOLs.** One idea is the *inability hypothesis,* which states that JOLs are poor because people have little conscious awareness of their own mental processes (Nisbett & Wilson, 1977). We lack the ability to assess our own learning. An alternative is the *monitoring-retrieval hypothesis*, which states that JOLs are poor because people are assessing whether they can retrieve information. When JOLs are made soon after the information was encountered, that knowledge is still in working memory. As such, people think that the information is better learned than it actually is.

These theories were tested by Nelson and Dunlosky (1991; Dunlosky & Nelson, 1994; Scheck, Meeter, & Nelson, 2004). They elicited JOLs either immediately or after a delay. If the inability hypothesis is correct, then a delay should not matter. However, if the monitoring-retrieval hypothesis is correct, then after a delay, working memory will be cleared out, and people will depend more on long-term memory and judge their future performance more accurately. In one study (Dunlosky & Nelson, 1994), people learned a set of words either through rote rehearsal or by forming mental images. As discussed in Chapter 3, memory is better when people use imagery. As shown in Figure 14.1, when JOLs made immediately after studying showed little to no distinction between how well the information was actually learned. However, with a delay, the difference between the JOLs in these conditions was the same as that is revealed by actual memory performance (see Kimball & Metcalfe, 2003, for an explanation based on distributed practice).

These JOL improvements are consistent with Koriat's (1993) accessibility hypothesis. The low correspondence between immediate JOLs and later memory may be due to the mismatched conditions when a person is studying (the information is present) versus at test (the information is absent), making it difficult to predict future performance (Koriat & Bjork, 2006). JOLs are more accurate the closer the conditions at the time the judgments

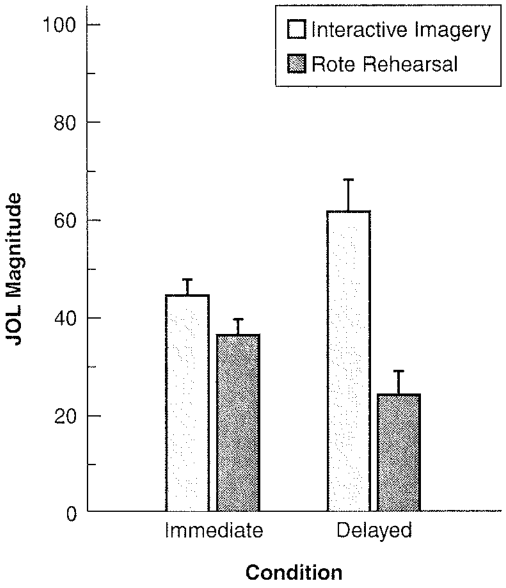

**FIGURE 14.1 Judgments of Learning. Words were learned under imagery or rote memorization instructions, given either immediately or after a delay**

*Source:* Dunlosky, J., & Nelson, T. O. (1994). Does the sensitivity of judgments of learning (JOLs) to the effects of various activities depend on when the JOLs occur? *Journal of Memory and Language, 33,* 545–565.

are made to those at memory retrieval. When people can properly assess what is available in long-term memory, JOL estimates are more accurate.

**JOL Cues.** JOLs are affected by three types of cues: extrinsic, intrinsic, and mnemonic (Koriat, 1997). Extrinsic cues concern aspects of the learning situation, such as massed or distributed practice, or presentation times. People are not attuned to how external characteristics influence learning, and JOLs are not affected by extrinsic cues. Intrinsic cues are aspects of the material being learned, such as the perceived ease of learning each item. In contrast to extrinsic cues, JOLs are sensitive to intrinsic cues, in line with the cue familiarity hypothesis. Finally, mnemonic cues are memory-based sources of information, such as assessments of how a person has done on previous judgments. Over time, if people continue to make JOLs, they shift from using intrinsic cues to using mnemonic cues, in line with the accessibility hypothesis.

Additional information does not always improve JOLs. In some cases, JOLs can actually worsen. For example, multiple study–test cycles can worsen JOLs over time (Koriat, 2002). Declines in JOLs also occur when there is competition among memory traces. In the fan effect (see Chapter 7) retrieval is more difficult with an increased number of associations with a concept. This also lowers JOLs (McGuire & Maki, 2001). When additional memory traces compete with a desired memory trace, people judge that they do not know information, so JOL estimates are decreased. This is in line with the competition hypothesis.

**Allocation of Study Time.** Although JOLs can be inaccurate, people do have some sense of their own learning. These JOLs impact how people allocate their study time (Metcalfe & Finn, 2008a). Ideally, study time should maximize the amount of new knowledge that is learned. Spending all your time on material you know well is less effective. It may increase overlearning, but it does not help you learn new things.

Although people can allocate study time based on a goal to learn certain items over others (Ariel, Dunlosky, & Bailey, 2009), in general, they regulate study time based on how easy they think pieces of information are to learn. However, this allocation is not always effective. People may choose distributed practice for easy items and massed practice for hard items, which is ineffective (Son, 2004; but see Benjamin & Bird, 2006, for an alternative account). When people first encounter information, they tend to focus more effort on the difficult items, often using massed practice (and also gives the illusion of harder studying). Moreover, because these items are so difficult, people have trouble learning anything new. They spend most of their effort on things that are far from being learned. As a result, there is little gain of new knowledge. This is the **labor-in-vain effect** (Nelson & Leonesio, 1988).

However, the picture is not completely dismal. As people gain experience with the new material, study time allocation becomes more effective. People shift to spending more time on items that are just beyond their current ability level. This is called the *region of proximal learning* (Metcalfe, 2002, 2009; Metcalfe & Kornell, 2003). This method is more efficient because people spend less time on knowledge that is way beyond their ability, but focus on things that can help them ratchet up to the next level.

## Feeling of Knowing

When you forget things, it does not always feel the same. Sometimes you don't know something and it seems like you never learned it. Other times, you don't know the answer, but you feel that it is somewhere in memory, and if you heard or saw it, you would be able to identify it. These forgetting differences are revealed by **feeling of knowing** (FOK) judgments (Hart, 1965).

To get FOK judgments, people are asked a series of moderately difficult questions, such as "Who was Richard Nixon's vice president before Gerald Ford?" Some things were never learned, but others were learned but are no longer prominent. After failing to recall an answer, people make an FOK judgment by rating how likely it was that they would identify the answer on a later recognition test. Then, at the end, people are given an actual recognition test to see how well their FOK judgments corresponded to actual memory. In general, FOK judgments are reasonable predictors of future memory, although there are some deviations (Hart, 1965).

According to the cue-familiarity hypothesis (Reder, 1987), FOK judgments are based on the familiarity of information in the question or cue. One way to test this is by using the "game show" method (Reder, 1987), in which people are given a question and then either answer it (control condition) or indicate that they know the answer (game show condition). This is called the game show method because it is like a game show in which the contestants are asked a question and the one who hits the buzzer first gets to answer. This technique reveals that people know whether they have information in memory before they actually retrieve it (Reder, 1987), as shown in Figure 14.2. Moreover, the rate at which people indicate that they know an answer is related to the familiarity of the information in the question and not necessarily what is in memory (Reder & Ritter, 1987). Similarly, people give higher FOK ratings to things they think they ought to know, rather than what they actually do know (Costermans, Lories, & Ansay, 1992). In general, FOK involved a controlled assessment of memory as people with frontal lobe damage are much less accurate on FOK tasks (Janowski, Shimamura, & Squire, 1989).

FOK judgments are related to how much partial information is retrieved (Koriat, 1993, 1995). Most of this partial bits are semantic attributes of what people are trying to remember (Koriat, Levy-Sadot, Edry, & de Marcas, 2003), such as failing to recall a name, but knowing that the person was a nineteenth-century composer who lived in Germany. However, metamemory judgments can be tricked. FOK increases when information is revealed slowly rather than presented all at once, showing a revelation effect (Chapter 12) (Young, Peynircioğlu, & Hohman, 2009). With a large amount of accurate partial information, there is a high correspondence between FOK ratings and future memory. However, if the partial information is incorrect, the correspondence is lower. This is why the overall relation between FOK ratings and actual memory is not ideal. Partial information also predicts whether what is eventually retrieved is "remembered" or is just "known" (Hicks & Marsh, 2002; see the remember-know section later in this chapter). A cue-familiarity account applies more to the early stages of the processing, which is related to "known" information. However, an accessibility account applies more to later stages, when cue familiarity is high and people have gone past the initial evaluation stage (Koriat & Levy-Sadot, 2001), which is related to "remembered" information. Finally, FOK judgments are affected by the number

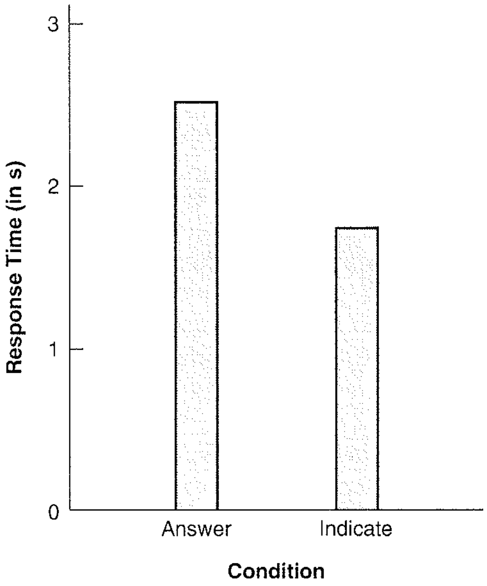

**FIGURE 14.2 Difference in Response Times. People either had to answer a question (control) or indicate that they knew the answer (game show)**

*Source:* Reder, L. M. (1987). Strategy selection in question answering. *Cognitive Psychology, 19,* 90–138.

of competitors involved. If people are trying to remember something, FOK ratings are higher if it has a smaller set of competitors (Schreiber, 1998; Schreiber & Nelson, 1998), in line with the competition hypothesis.

## Tip-of-the-Tongue State

A **tip-of-the-tongue (TOT) state** is when people fail to recall information but feel that they are about to retrieve it. It is on the tip of their tongues [Brown & McNeill, 1966; see Thompson, Emmorey, & Gollan, 2005 for an account of a tip-of-the-fingers (TOF) state for deaf signers]. This seems like a FOK judgment. However, a FOK judgment assesses whether a person thinks information can be remembered, whereas a TOT state indicates that remembering is imminent (Brown, 1991; Schwartz, 2001). Also, FOK and TOT judgments are differentially affected by a working memory load (e.g., remembering sets of digits), with FOK judgments increasing or unaffected, but TOT rates decreasing (Schwartz, 2008). With a higher working memory load, it is harder to evaluate partial information being retrieved for FOK judgments. However, TOT rates are lower because less partial information is retrieved into working memory because it is being blocked by the information that is being actively maintained as part of the dual task.

There are a number of characteristics of TOT states (Brown, 1991). First, people experience them about once a week on average. Second, there is often some information available. People typically can think of words that are similar to the one that is needed, either in terms of meaning, sound, or both. Third, people in a TOT state often have trouble with proper nouns, such as names. Fourth, people in a TOT state may be aware of the first letter or sound, and perhaps the last one as well, of the word, along with the number of syllables. Finally, the occurrence of TOT states is not related to feelings of stress or anxiety.

One theory of the TOT state is the *incomplete activation view* (e.g., Brown & McNeill, 1966). A TOT state occurs when the search range has not been sufficiently narrowed. There are too many possibilities, so the person cannot retrieve the desired word. Another theory is a *blocking view*, in which TOT states occur when related but inappropriate competitors are activated to a greater degree and block access to the appropriate information. These blocking memories, rather than the appropriate one, are being retrieved, making it harder to access the target memory. People keep retrieving the wrong one. Moreover, because these wrong traces have been retrieved recently, they are more available and so are more likely to be retrieved again. This starts a vicious cycle, resulting in the TOT state.

## Knowing That You Don't Know

Sometimes we feel like we know something, even if we can't remember it at the moment. Other times, we know that we just **don't know** something. No matter how long we search, we know that the information can never be remembered. For example, if I asked you "When was the city of Lakewood, Ohio, founded?," "Is *scissel* a word?," or "Does President Obama use an electric toothbrush?," most of you know immediately that you do not know the answer. What is interesting about these "don't know" judgments is that people make them as rapidly, if not more rapidly, as they do about knowledge that is actually in memory (Kolers & Palef, 1976). Why does this occur?

Feeling that you don't know something is different from feeling that you do know something (Liu, Su, Xu, & Chan, 2007).When people are asked about very unfamiliar topics, they can rapidly make a judgment based on the information in the question, consistent with the cue-familiarity hypothesis (Reder, 1987). For a question with very unfamiliar information, because memory retrieval does not get very far in starting, people can quickly identify the information as unknown.

In support of this, in a study by Glucksberg and McCloskey (1981), people first explicitly learned that they did not know certain items, such as "It is unknown whether John has a pencil" (*explicit don't know*) along with items that were known, such as "John has a shovel" (*true*) and "John does not have a chair" (*false*). After learning, people made "yes," "no," and "don't know" responses to these items, as well as to new items that they would not have known about. People were slower and less accurate in saying that they did not know something if they had previously learned that they did not know it than if they had never studied it (see Figure 14.3). Thus, by having something in memory for the "don't know" facts that were learned, there is now something for memory to access, so retrieval time slows down. However, when nothing was learned, there is nothing in memory, so rapid "don't know" responses are made.

Finally, when asked questions about things people don't have in memory, if the information is distinctive, it will not make contact with many memory traces. This is a failure to retrieve any information in a very short period of time. Based on this lack

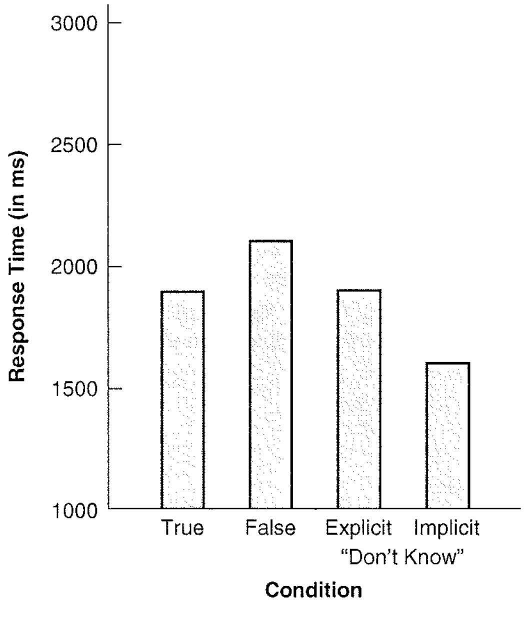

**FIGURE 14.3 Difference in Response Times. Questions were true, false, or unknown. "Don't know" responses were for facts that were either learned earlier as "don't know" (explicit) or not (implicit)**

*Source:* Glucksberg, S., & McCloskey, M. (1981). Decisions about ignorance: knowing that you don't know. *Journal of Experimental Psychology: Human Learning and Memory, 7,* 311–325.

of retrieval, a person can judge that the information is not known (Ghetti, 2003), consistent with the accessibility hypothesis.

### Synopsis

Judgments of learning are important for learning. Unfortunately, the relationship between JOLs and later accuracy is often low. Part of this is because people make JOLs before clearing out what is in working memory. People use their JOLs to manage their study time in inefficient ways and may spend too much effort studying things that are too hard. With more experience, however, a person learns to use what is already known as a springboard for learning new things. When people forget something, they can estimate whether they know it, even if it is not currently available, as with feeling-of-knowing judgments. These judgments are fairly accurate, but not perfect. FOK judgments are based on either partial information or an assessment of the familiarity of a cue. When remembering seems imminent, it is a tip-of-the-tongue state. FOK inaccuracies often occur because the information is in a domain that the person has substantial knowledge of, so they inappropriately judge that the item is known, or because it is in a domain that they have little knowledge of, so they judge that it is not known. Finally, when there is no information in memory, people can quickly say that they do not know something.

## MEMORY PHENOMENOLOGY

In this section we look at the phenomenology or conscious experience of remembering. We first look at the difference between conscious and unconscious memories as outlined by the remember-know distinction. Then we cover how errors in recollection lead us to misunderstand what we were like in the past, as with the hindsight bias.

### Remember Versus Know

At this point let's consider where people rate the quality of what they do remember by making a **remember-know judgment** (Gardiner, 1988; Tulving, 1985b). If the remembering is accompanied by a conscious recollection of the circumstances in which the information was learned, this is a "remember" experience (although Rubin, Schrauf, & Greenberg, 2003, suggest that "remember" responses reflect a *belief* that an event occurred). In contrast, if people do not consciously recollect but only have a feeling of familiarity, this is a "know" experience. This distinction between "remember" and "know" parallels issues discussed in Chapters 6 and 10, such as the difference between autonoetic (remember) and noetic and anoetic (know) knowledge in Tulving's (1985b) Triarchic Theory, and the dual trace models of memory.

**The "Remember" and "Know" Distinction.** A great deal of research has been done on the remember-know distinction (Gardner & Java, 1990, 1991; Gardiner & Parkin, 1990) and how it reflects memory processes and experience (summarized by Gardiner & Java, 1993, and Gardiner & Richardson-Klavehn, 2000). "Remember" and "know" responses reflect distinct qualities of memory (Dudukovic & Knowlton, 2006). Research has shown a double dissociation between these types of responses, such that things that affect one type of response do not affect the other, and vice versa. Thus, remembering and knowing reflect different ways of using memory and are not just after-the-fact labels that people apply to their experiences.

"Remember" but not "know" responses are affected by depth of processing, generation effects, frequency of occurrence, divided attention at learning, the retention interval (if less than a day), reading silently or aloud, intentional versus incidental learning, serial position, and external context (Gruppuso, Lindsay, & Masson, 2007). As an example, if you read something aloud, you are more likely to have a "remember" experience than if you read it silently. However, the probability of giving a "know" judgment would be the same, regardless of how you read the text.

In contrast, "know" but not "remember" responses are affected by repetition priming, stimulus modality (e.g., visual or auditory), amount of maintenance rehearsal, and suppression of focal attention. For example, if you engage in maintenance rehearsal and repeat a word over and over, this does not alter the degree that you later recollect it. However, you are more likely to say that you "know" that you learned it.

Also, "remember" and "know" responses can both affect but in opposite ways, such as "remember" responses being more common and "know" responses being rarer. Cases of this type are word versus nonword memory, massed versus distributed practice, gradual versus abrupt presentations, and learning that emphasizes similarities or differences (e.g., Cook, Marsh, & Hicks, 2006a,b). For example, with massed practice, "remember" responses are less likely and "know" responses are more likely.

These "remember" and "know" metamemory responses correspond to memory differences. For example, "remember" responses correspond to knowledge-based, conceptually driven processing, and "know" responses correspond to perceptually based, data-driven processing (Rajaram, 1993). This distinction is also supported neurologically. For example, relative to "know" responses, "remember" responses involve greater parietal lobe activity (Curran, 2000; Wilding, 2000), greater EEG activity (Burgess & Ali, 2002), and more hippocampus activity, whereas "know" responses reflect more parahippocampus (around the hipposcampus) activity (Meeter, Myers, & Gluck, 2005).

This "remember" and "know" distinction reveals differences between expert's and novice's memories. The influence of prior knowledge, such as schemas, on retrieval is often observed with recall but less frequently with recognition. Experts almost always recall more accurately than novices, but these two groups do not differ on recognition tests. This is related to the fact that experts are more likely to give "remember" reports, whereas novices are more likely to just say that they "know" it. In a study at the University of California, Davis, Long, and Prat (2002) had students read stories based on the television series *Star Trek.* Some of the students were experts (people who watch the show a lot), and some were novices (people who watched the show only occasionally). The two groups performed similarly on a recognition test of the stories. However, the experts were more likely to report that they remembered reading the items, whereas the novices were more likely to say that they knew it. The experts' prior knowledge allowed them to spend more time making inferences and elaborating on the memory traces they were creating, which made it more likely that they would have an experience of remembering it.

## Hindsight Bias

One characteristic of human thought is that people tend to think of events as being more deterministic after the fact. This is the **hindsight bias,** and this increased deterministic thought is called "creeping determinism" (Fischhoff, 1975). For memory, the hindsight bias is seen when people misremember their mental state as being different from what it really was and being more like their current knowledge state.

In a study by Safer, Bonanno, and Field (2001), bereaved spouses rated their grief 6 months after the death and then 4 1/2 years later. At the second rating, people also rated how much grief they felt at the 6-month period. Although most people said they felt more grief at the 6-month period, their memory of their experience was positively related to their current level of grief. Thus, they misremembered their emotional states in hindsight based on their current state (see also Levine et al., 2001).

Other examples of the hindsight bias are memories for people's predictions of outcomes of the Rodney King civil rights trial (Gilbertson, Dietrich, Olson, & Guenther, 1994), the Clarence Thomas Supreme Court Justice confirmation vote (Dietrich & Olson, 1993), the probability of a medical diagnoses being correct (Arkes, Wortman, Saville, & Harkness, 1981; Detmer, Fryback, & Gasser, 1978), the results of political elections (Blank, Fischer, & Erdfelder, 2003; Leary, 1982; Powell, 1988), the outcome of sporting events (Leary, 1981), the inevitability of a work layoff (Mark & Mellor, 1991), and memory for faces (Harley, Carlsen, & Loftus, 2004). This reinforces the point that our memory is in a constant state of flux and that what we currently remember is in part due to our experiences and current state.

The hindsight bias also applies to romantic relationships. People's relationship memories are biased in the direction of their current opinion. People who are pleased remember events more positively than people who are unhappy (McFarland & Ross, 1987). Moreover, even when relationship satisfaction is constant, people misremember it as improving over time (Sprecher, 1999). This leads to an unusual idea that people in satisfactory relationships, even for marriages over 20 years, are biased to remember the past as worse than it was, although they remember the relationship positively overall. This bias is a trick that makes the relationship seem to be improving more than it actually is (Karney & Coombs, 2000). So, people have a more positive attitude toward their relationship than if memory were accurate.

The hindsight bias is driven by a need to reconcile one's current view with memory for the past. For example, people show a larger hindsight bias when outcome information is surprising than if it is more congruent with what one knows (Ash, 2009). The act of trying to make sense of a surprising outcome leads people to think more about the information, reconciling it with what is already known, thereby leading to the false impression that the information was better known than it actually was.

**The Knew-It-All-Along Effect.** A variant of the hindsight bias is the **knew-it-all-along effect** (Fischhoff, 1977; Wood, 1978) in which people evaluate information in some way at Stage 1—for example, judging whether a series of statements are true or false, such as "Lhasa is the capital of Nepal." Then, at Stage 2, people are given feedback about the information encountered at Stage 1, such as learning that Kathmandu is the capital of Nepal. This feedback is likely to be knowledge that the person did not have at Stage 1.

Finally, in Stage 3, people indicate their memory for what they knew at Stage 1. Compared to people who got no feedback at Stage 2, metamemory reports of prior knowledge are biased toward the information learned during Stage 2. After Stage 2, people have a hard time remembering what it was like not knowing something, as if they knew it all along.

The knew-it-all-along effect can be reversed if the more recent learning is discredited in some way. For example, if you didn't know the capital of Nepal originally, were then told the capital name, you might show a knew-it-all-along effect and state that you knew this information before. However, if you were then told that this information was wrong, this would reverse the bias, and there would be a more accurate assessment of what was and was not known (Erdfelder & Bechner, 1998; see also Hasher, Attig, & Alba, 1981). A similar knew-it-all-along effect reduction can occur if people retrieve information that was only recently learned, rather than what they remember knowing before the new knowledge (Begg et al., 1996). People who monitor source information are better able to assess whether knowledge is recent. Just encouraging people to try harder has no influence (Fischhoff, 1977). Asking people to try to remember something, even after it becomes hard to think of other alternatives, may increase the potency of a hindsight bias because additional retrieval attempts make the outcome seem more like it was known (Sanna & Schwartz, 2004; Sanna, Schwartz, & Small, 2002).

In general, it is difficult for us to remember what it was like when we did not know something. College professors are no exception. If you have ever felt that one of your instructors was talking over your head, it may not be because he or she was arrogant, or uncaring. The problem may have been that, because of the knew-it-all-along effect, he or she was having trouble remembering what it was like to learn the course material for the first time.

**Remembering Forgetting.** Another illustration of the hindsight bias is people's memories for their own memory. Specifically, how well do people remember whether they had remembered or forgotten something previously? In a study by Joslyn, Loftus, McNoughton, and Powers (2001), people were tested 1 day and 6 weeks after originally learning information. At the 6-week session, people were also asked whether they had remembered or forgotten specific items at the first session. People were more accurate at remembering their previous memory successes but were less accurate at remembering their previous instances of forgetting. About half the time a person had originally forgotten an item, it was later reported that it had been remembered. Thus, there is a metamemory bias to think that we have better memories than we do.

**Remembering Beliefs.** Memory can be affected more globally as well. In a study by Winkielman and Schwartz (2001), some people were told that sad events fade quicker from memory, whereas others were told that happy events fade quicker. People who were told that sad memories are forgotten quicker were more likely to rate their childhood as less happy, especially following a difficult autobiographical memory task. It is as if people think that if they have forgotten many sad memories, then their childhood must have been less happy than they would have otherwise rated it.

Another influence of beliefs on memory and the hindsight bias, people misremember their features of options to be more consistent with their own choices (Henkel & Mather, 2007). For example, people might be given descriptions of both positive and negative features of cars (e.g., comfortable seats, good handling, has dents, not much trunk space) and are then asked to choose which car they prefer. Later, when those people are asked to assign the various features to the original choices, they are more likely to misremember the positive features as being ones for the choice they selected, and the negative features for the choice they did not select. So, people show a memory bias to think that things that are consistent with their own beliefs have more positive and fewer negative characteristics than they actually do.

### Synopsis

Remembering is accompanied by different conscious experiences, as seen with the difference between "remember" responses (associated with conscious recollection) and "know" responses (associated with unconscious feelings of familiarity). This distinction is supported by neurological and behavioral dissociations. Metamemory awareness sometimes leads people astray, as with the hindsight bias. Essentially, people assess the past in a way that is more consistent with the present.

## MEMORY MONITORING AND CONTROL

In this section we look at the conscious monitoring and control of memory. This involves how we use our memories to remember to do something in the future, which is called prospective memory. In addition we look at the ability to consciously remove information from memory through the direct forgetting procedure.

### Prospective Memory

**Prospective memory** is used to remember to do things in the future (Loftus, 1971). Remembering to give your roommate a message or take the pizza out of the oven in 20 minutes are both examples of prospective memory. This is in contrast to **retrospective memory**, or memory for things learned in the past. Prospective memory is covered in this section on metamemory because one must monitor one's own memory to know when some action is to be taken in the future. Like other memory monitoring abilities, this is disrupted by damage to the frontal lobes (Burgess & Shallice, 1997; Cockburn, 1995).

Prospective memory has been tested in a number of ways. Some of these are naturalistic, such as having people remember to make a call at certain times (West, 1988). Others are laboratory-based, such as having people press a button when they see a certain word (Einstein & McDaniel, 1990) or after a certain amount of time has elapsed. This gives the researcher more control over what people use to help them remember. For example, in naturalistic studies, people could write reminders on a calendar or a sticky note.

**Components of Prospective Memory.** There are many differences between prospective and retrospective memory. For example, as we will see in Chapter 15, while aging has a profound effect on retrospective memory, the changes to prospective memory are more subtle (Burgess & Shallice, 1997; Einstein & McDaniel, 1990). In general, prospective memory performance has relation to retrospective memory performance on tasks such as recall and recognition.

Prospective memory involves several components: (1) monitoring the environment for a cue to do something, (2) remembering what to do in the future, (3) retrieving the memory of what to do, and (4) actually doing it. Number 2 is similar to retrospective memory. Thus, prospective memory depends on retrospective memory, not vice-versa. The other parts are unique to prospective memory. The monitoring the environment for a cue to remember is an element that is absent in retrospective memory. This is supported by neurological findings, such as an MEG study by Martin et al. (2007) that revealed that prospective memory monitoring involved activation of posterior parietal lobe areas, whereas the later remembering of what to do involved activation of the hippocampus, similar to a retrospective memory task. This constant monitoring of the environment comes at a cost as people then have fewer memory resources for other tasks, especially if they have a relatively large number of things that they need to remember to do (Cohen, Jaudas, & Gollwitzer, 2008; Hicks, Marsh & Cook, 2005). So, when you have a lot to do, you are more likely to make a prospective memory error, and forget to do something.

The importance of control over memory in prospective memory is evidenced by the link with the frontal lobes and conscious awareness. Prospective memory requires some conscious control of thought, and so people are more aware of their prospective than their retrospective memory errors. People who complain about memory problems are more likely to have prospective memory problems (Mäntylä, 2003).

**Types of Prospective Memory.** There are two types of prospective memory: event based and time based (Einstein & McDaniel, 1990). Event-based prospective memory occurs when people need to remember to do something when some event occurs—for example, remembering to give a person a message when you see him or her. Event-based prospective memories differ from retrospective memories in that while increased retention intervals make retrospective memory worse (the forgetting curve), prospective memory actually may get better (Hicks, Marsh, & Russell, 2000). This may be because, as time passes, people repeatedly remind themselves of what they need to do, thereby improving their performance.

Event-based prospective memory is complicated. It can be influenced by the relation between the event that is supposed to signal people to remember and the action that is to be done (McDaniel, Guynn, Einstein, & Breneiser, 2004). When the event and the action are semantically related (e.g., write down the word "needle" when you hear the word "thread"), prospective memory is more automatic and is less influenced by divided attention. However, if the event and action are not related (e.g., write down the word "needle" when you hear the word "parasol"), prospective memory is more deliberative and is more disrupted by divided attention. Event-based prospective memory is also more difficult when there are multiple cues as opposed to one, and even more difficult if these cues are unrelated to one another (Marsh et al., 2003). In essence, as attention is drawn further away from the prospective memory task by different things in the environment, memory worsens. Event-based prospective memory can be improved if a person makes a clear public statement of the intention to do something in the future (McDaniel, Howard, & Butler, 2008). This may be driven by a desire to fulfill social commitments and be viewed positively by others, thereby giving the prospective memory task higher priority in cognition, making it more likely to be done.

Time-based prospective memory occurs when people need to remember to do something at a certain time or after a certain time interval. Remembering to call home on

Mother's Day or to take another pill in 4 hours are examples of time-based prospective memory. Time-based prospective memory is harder than event-based (Einstein et al., 1995) because with event-based prospective memory, there is something in the environment to remind the person. With time-based prospective memory, it is up to the person alone. We can improve time-based prospective memory by making it more event based. For example, you could set a timer and wait for it to go off (an event) to remind you to take your pill.

With time-based prospective memory, people make more errors if the tasks are repetitive—for example, taking medications after certain time intervals. The more a person has done the task, the more likely an error will be made and the person will forget. Part of what is going on is that source monitoring errors occur, which then cause problems with prospective memory (Einstein, McDaniel, Smith, & Shaw, 1998; Marsh, Hicks, Hancock, & Munsayac, 2002). For example, a person is confused and thinks he or she has just taken the medication, when in fact he or she is remembering another time that it was done. This is a case where doing something frequently actually makes memory worse, not better.

## Directed Forgetting

Most of the metamemory topics covered here are about how people try to remember. However, there are times when we do not want to remember, and want to forget. An everyday example of this is if someone was telling you his or her phone number, and then realized he or she gave you the wrong one and said "Oh, wait, that's not the number, the number is . . ." Clearly you want to forget the incorrect number. This process is **directed forgetting** (Bjork, 1970; Geiselman, 1974), the metamemory action of removing information from memory. In an experiment people might be given a list of words, told to forget them, and then be asked to remember a new set of words. Here, memory for the to-be-remembered (TBR) words is the same as if the participant had never been given the to-be-forgotten (TBF) words (Epstein, Wilder, & Robertson, 1975). There is no proactive interference from the TBF words. This is the directed forgetting effect. Interestingly, information that precedes an instruction to forget may experience greater retroactive interference as the effects of the forgetting extend further back in time than it should (Sahakyan, 2004; see Delaney, Nghiem, & Waldum, 2009, for directed forgetting of information related to narrative characters).

Part of the explanation for directed forgetting is that people inhibit the irrelevant TBF memory traces (Bjork, 1989) to keep them out of the current stream of processing does not disrupt the practice of the TBR information (Basden, Basden, & Morales, 2003). This is also consistent with the finding that people with higher working memory spans are better at directed forgetting (Delaney & Sahakyan, 2007), and the idea that working memory span reflects the ability to effectively control mental processing.

This inhibition of the TBF information is pervasive. It occurs both for direct memory tests, like recognition and recall, and indirect tests, like word fragment completion and repetition priming (MacLeod, 1989; but see Racsmány & Conway, 2006, and Racsmány, Conway, Garab, & Nagmáté, 2008 for evidence that directed forgetting primary influences conscious "remember" not unconscious "know" responses, and does not disrupt semantic priming). For autobiographical memories its effectiveness is unrelated to emotional quality (Barnier et al., 2007). For enacted tasks (things that you do rather than only think of or watch somebody else do), it occurs although to not as great a degree for verbal information (Sahakyan & Foster, 2009). Moreover, inhibiting irrelevant memories is effortful, even if we are not aware of it. When people are disrupted by an unrelated secondary task, the inhibition of TBF items is reduced or eliminated (Conway et al., 2000).

Directed forgetting may not occur if people believe that the information they are told to forget will be relevant later (Golding, Fowler, Long, & Latta, 1990), or if the TBF information is meaningfully (semantically) related to TBR information (Golding, Long, & MacLeod, 1994). Presumably, the automatic priming of TBF items by TBR items keeps it from being effectively forgotten. Directed forgetting is also reduced if the TBF information is consistent with a person's beliefs. For example, during the 2003 Iraq war, misinformation was sometimes reported by news outlets, such as a report that Iraqi forces were executing coalition prisoners of war. After misinformation was denied or corrected by the news agencies, people who were more suspicious of the motives for the war were more successful at forgetting and discounting the misinformation than people for whom it was consistent with their beliefs about the reasons for the war (Lewandowsky, Stritzke, Oberauer, & Morales, 2005).

### Synopsis

People need to know what to do in the future and when to do it. This is prospective memory. Although it shares some aspects with retrospective memory, it is also guided by some of its own processes. Prospective memory tasks can be either event based or time based. Event-based prospective memory is generally easier and may improve with the passage of time. In comparison, time-based prospective memory is harder and is more susceptible to source monitoring errors. With directed forgetting, people can exert conscious control over their memories by deliberately removing traces that are deemed to be irrelevant.

## MNEMONICS

When we are aware of the limitations of our own memory, we can take steps to address this. One thing we can do is to use metamemory techniques, known as mnemonics. **Mnemonics** are mental or physical devices used to help people remember. There are a number of ready-made mnemonic devices that can be used as structured cue sets to help remember larger sets of information. One example is the *peg-word mnemonic*, in which people use a known sequence of items, or "pegs," on which to "hang" other pieces of information. For example, people might memorize the sequence "One is a bun, two is a shoe, three is a tree, (and so on)." This structure can then be used as a set of pegs for other information. For example, suppose you needed to go to the grocery store to buy onions, milk, and watermelon. You could use the peg word mnemonic by forming a mental image of sliced onions on a bun, a shoe full of milk, and watermelons hanging from a tree. When you get to the store, your sequence of pegs will help you remember the images you formed, which will help you remember what you need to buy.

Another common mnemonic is the *method of loci*. In this mnemonic a person first has a set of well-known locations. These can be rooms in a house, locations along a familiar path, and so on. A person then imagines things at each location. To use our grocery shopping example, a person might mentally place the onions in the living room, cartons of milk at the foot of the stairs, and watermelons in the dining room. Then, to remember, the person takes a little mental tour of his or her home.

Other mnemonics take advantage of the information itself. A *rhyming mnemonic* takes all the information and forms a rhyme from it. For example, "Thirty days hath September, April, June, and November" is a rhyming mnemonic for the number of days in the months. *Acronyms* are a mnemonic in which the first letters of phrase help people remember. For example, the word HOMES is an acronym for the names of the five great lakes: Huron, Ontario, Michigan, Erie, and Superior. Finally, *acrostics* are a mnemonic, in which the first letters of the items are used as the basis of forming some new memorable phrase. For example, the phrase "On Old Olympus' Towering Top, A Finn And German Vault And Hop" can be used to help a person remember the names of the twelve cranial nerves in their correct order: olfactory, optic, oculomotor, trochlear, trigemenal, abducens, facial, auditory, glossopharyngal, vagus, accessory, and hypoglossal (premed students take note!). Remembering the phrase provides the cues to the appropriate names as well as preserving the correct sequence of the information.

There are many mnemonics people can use. Sometimes a mnemonic is a simple cue, like tying a string around your finger. Other times, the structure of the mnemonic helps a person remember the information itself, such as the knuckle mnemonic, which is another way of remembering how many days there are in each month (see Figure 14.4) with the knuckles being the months with 31 days and the valleys standing for months with 30 days or fewer. Regardless of the specific mnemonic, in all cases, the ability to cue memory is at work, in much the same way as the other sorts of cues we've talked about (see Chapter 7).

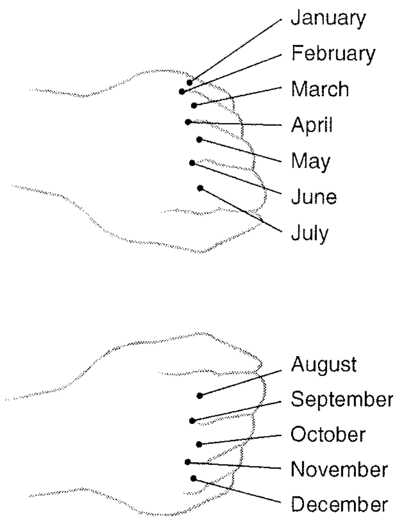

**FIGURE 14.4 The Knuckle Mnemonic**

### Synopsis

People can use their metamemory knowledge to help them remember better, such as with mnemonics. Most mnemonics rely on some well-known or readily available, consistent structure that can then be used as a guide to help a person remember what they are interested in retrieving.

## EXCEPTIONAL MEMORY

Having an awareness of one's own memory can help improve how it is used. Further improvements can occur as the range of knowledge is broadened. The more you know, the easier it is to remember because it is easier to organize and chunk information. Thus, expertise can cause a person to have what would otherwise seem an exceptional memory for certain types of information.

We saw some of this in Chapter 4 when discussing how to improve the capacity of short-term memory and still have 7 ± 2 chunks of information, as with the case of S. F., a runner who extended his digit span up to over 80 items (Ericsson, Chase, & Faloon, 1980). Another example of this is that taxi drivers' memories for street names are better than most people's. This superior memory is not due to their intelligence, but to both the large amount of knowledge they have about streets in their city and the highly organized way this information is represented. For taxi drivers, this information is chunked based on routes through the city (how they use this knowledge), rather than spatial proximity, semantic relatedness, or alphabetical order (Kalakoski & Saariluoma, 2001).

Other studies of exceptional memory are cases when the knowledge people are using is implicit. Speakers of tonal languages, such as Mandarin Chinese and Vietnamese, are better at memory for musical pitches and are more likely to have perfect pitch than speakers of nontonal languages, such as English (Deutsch, 2002). Because those languages place a greater demand on remembering pitch information, this knowledge can then be applied, at an unconscious level, to memory for the pitches of tones used in music.

### Memorists

There are cases of people with exceptional memories, people are called mnemonists or **memorists.** We use the term *memorist* because they are not relying on mnemonics as described previously (Neisser, 1982). A well-known memorist was Solomon V. Shereshevsky, better known as S., who lived in the Soviet Union in the early to mid-twentieth century (Luria, 1968). S. worked as a newspaper reporter in Moscow and had the uncanny ability to accurately remembering large sets of details from an event without taking any notes. S. had a short-term memory span of over 70 items, with the additional amazing ability of recalling them in any order requested. He could also recall lists of items years after hearing them only once.

A major contributor to S.'s ability was the fact that he had synesthesia. This is a condition in which sensory qualities from different modalities intrude on one another.

For example, different sounds may also be experienced as colors. S. had a particularly strong case of this. This made his memory traces very rich and detailed, allowing them to endure, be highly structured in memory, and be recalled accurately. While S.'s condition allowed him to remember exceptionally large sets of items, there were some drawbacks. For one, because he was so dependent on sensory and perceptual qualities, he found it difficult to comprehend and think about abstract ideas.

Not all memorists have an unusual neurological condition. Let's look at three, who were all in the *Guinness Book of World Records* for reciting pi from memory. The first is Rajan Mahadevan (Biederman, Cooper, Fox, & Mahadevan, 1992; Thompson, Cowan, & Frieman, 1993; Thompson et al., 1991) who set the record on July 5, 1981 by reciting pi out to 31,811 digits in 3 hours and 49 minutes. His memory ability was first observed at the age of 5 when his parents hosted a dinner party for 50 people. To occupy himself, Rajan memorized, in just a few minutes, the license plate numbers of all of the guests' cars and then reported them to the guests. Rajan has a letter span of 13, a visual digit span of 28, and an auditory digit span of 43. One strategy he uses is keeping track of the position of an item in a sequence. The sequence, with its various positions, serves as a mnemonic encoding and retrieval device. When he makes errors, they are often for digits at adjoining locations. This use of position as a memory aid makes Rajan treat information differently. For example, when given a list of words, Rajan is less likely to use semantic relations to help him remember. His performance on more complex information, such as stories and spatial information, is well within the normal range. So, his exceptional memory is confined to digits and similar information. Rajan earned a master's degree in clinical psychology from the University of Mysore in 1986 and a master's degree in cognitive psychology from Kansas State University in 1991. While he had good memory for digits, he had normal memory for other types of information. He sometimes tried to extend his memorization approach to other types of information but not always with the same level of success. He had a tendency to memorize information from a text or lectures. However, as many professors will tell you, while memorization is important, what is as important is the ability to apply and use that knowledge.

The second memorist is Hideaki Tomoyori who set his record on March 9, 1987 by reciting pi out to 40,000 digits in 13 hours and 6 minutes (Takahashi, Shimizu, Saito, & Tomoyori, 2006). Tomoyori has good skills for memorizing long lists of numbers, but his memory for word lists and stories is no different than everyone else (Takahashi, et al., 2006). Tomoyori accomplished his task by using a digit-symbol mnemonic in which the Japanese symbols for digits were combined to form words, and then images. The digit symbol mnemonic is like assigning letters to numbers in English, (e.g., 1 = t, d or th; 2 = n; 3 = m; etc.). Thus, his approach was very different from Rajan's. He also had large, but not far from normal, digit spans of ten for auditory digits and eight for visual digits, and his word and story memories were not meaningfully different from standard controls. Thus, Tomoyori achieved his feat not through an inherent talent, but through the persistent application of a particular strategy and a lot of effort.

Tomoyori's record was bettered by Chao Lu, who, on November 20, 2005, recalled pi out to 67,890 digits in 24 hours and 4 minutes (Hu, Ericsson, Yang, & Lu, 2009). Lu did this by relying on the phonology, or word sounds, of the various digits to recode the information linguistically, much like Tomoyori, and then develop stories for himself out of this information. However, he also developed techniques based on the shapes of the characters for the digits and their meanings. Lu has a normal digit span of about nine digits. Overall, these three memorists accomplished similar tasks using different talents and strategies to achieve a similar effect.

### Eidetic Imagery

Some people think they have photographic memories—the ability to use mental images in a way that resembles perceptually viewing an image. This is **eidetic imagery** (De Beni et al., 2007; Gray & Gummerman, 1975). Someone with this ability would have an extraordinary memory for information that was seen earlier, showing little to no distortion. In general, there is little support for the existence of eidetic imagery, and if it does exist it is very rare. For the most part, people who appear to have eidetic imagery are instead using other memory skills to a high degree. This is often restricted to a limited type of knowledge. If eidetic imagery does exist, it is present in some young children, but gradually disappears as a person ages (Haber, 1979), although there are reported exceptions (Stromeyer & Psotka, 1970).

### Synopsis

Some people have exceptional memories. In some cases, this comes with expertise. More exceptional cases are memorists who have memory skills that seem to defy the imagination. Often these memorists have exceptional memory for certain types of information but normal memory for other types. Finally, there is little evidence to suggest that there is something akin to a photographic memory. People who make this claim often have special strategies for handling certain types of information, and do not have memories that are highly detailed visual representations of what was seen earlier.

## SUMMARY

In this chapter we looked at metamemory, the awareness, monitoring, and control of one's own memory processes and content. There are a number of theories of metamemory. The cue-familiarity hypothesis focuses on the familiarity of external memory cues. The accessibility hypothesis focuses on information that is actually retrieved from memory. A number of metamemory processes were considered, including judgments of learning, feelings of knowing, and tip-of-the-tongue states. We have seen how one's current state of knowledge influences how we remember our own previous memories, as with the knew-it-all-along effect. We have also seen how memory can reach forward in time to allow us to plan and do things in the future (prospective memory). Many of these metamemory processes critically involve the frontal lobes, which control patterns of thinking in general. Finally, we discussed some mnemonic devices, as well as cases of people with exceptionally good memories, even if only for certain types of information. Being more accurately aware of your own memory abilities can serve you well.

## STUDY QUESTIONS

1. What are the sources of information available to people when making metamemory judgments? How do these relate to the major theories of metamemory?
2. How accurate are judgments of learning and how are they made? What can be done to improve judgments of learning?
3. How effective are people at allocating their study time, and why? In what ways are people ineffective? What are more effective ways to allocate study time?
4. What are feeling-of-knowing judgments? When are they given? How accurate are they?
5. What is the difference between feeling-of-knowing judgments and the tip-of-the-tongue state? What are some of the unique characteristics of the tip-of-the-tongue state?
6. How do people assess that they do not know something?
7. What is the difference between "remember" and "know" responses?
8. What are the hindsight bias and the knew-it-all-along effect? How can they be avoided?
9. What are the types of prospective memory? What influences their effectiveness?
10. What is directed forgetting? How is it accomplished? How does deliberately forgotten information affect memories of other information?
11. What neurological structures are strongly associated with metamemory performance?
12. How do mnemonics work? What are some examples of mnemonics?
13. What are some of the ways that people can exhibit exceptional memory performance?

## KEY TERMS

accessibility hypothesis, competition hypothesis, cue-familiarity hypothesis, directed forgetting, don't know, eidetic imagery, feeling of knowing, hindsight bias, judgments of learning, knew-it-all-along effect, labor-in-vain effect, memorists, metamemory, mnemonics, prospective memory, remember-know judgment, retrospective memory, tip-of-the-tongue (TOT) state

## TRY IT OUT

An important feature of metamemory is the ability to exert some control over your own learning and memory. For this Try It Out section, two types of studies are outlined to illustrate this. These are tests of directed forgetting and mental imagery, and their influence on the ability to remember. Ideally you should have at least 16 participants for each of these tasks, with at least 16 people in each group if you vary things in your own experiment between groups.

- To assess the influence of **directed forgetting**, you should create a list of 30 words, divided into two lists of 15 words, such as five- to seven-letter two-syllable nouns. Read this list to two groups of people. For the first group (the control group), label the first list as "List A" and then read the words to them. In all cases, read the words at a rate of one word per second. When you get to the end of the first list say "O.K., try to remember List A. Now I am going to read you List B, which you also need to remember" or something similar. Then read them the second list. For the second group (the directed forgetting group), after you read the first list say "O.K., try to forget List A. Now I am going to read you List B, which you do need to remember" or something similar. At the end of the second list, have the people in both groups try to recall as many words from List B as they can. If all goes well, because of continued proactive interference, people in the control group should recall fewer List B words than the directed forgetting group. If you want, you can also then have people try to recall the List A words. People should recall fewer List A words in the directed forgetting group.
- Here is how you can show the effectiveness of **imagery** and **mnemonics** to improve memory (Neath, 1998). First, create a list of 40 concrete nouns (things like dog, house, rope, etc., and not truth, justice, or hope). Give people 20 random pairings of these words. Tell them that they will later need to be able to recall the second word when given the first. For one group of people (the control group) simply tell them to memorize the word pairs as efficiently as possible. For the second group (the imagery group) tell them to try to form a mental image in their mind that involves the two words represented as objects interacting in some way (they don't need to tell you what their images are). Give people in both groups 5 seconds per word pair during the study portion. Then, at the end of the study portion, give people the first words of each word pair and see if they can recall the second. You can do this by giving them a sheet of paper with the first words in a column and have them write down the other word next to the appropriate first word. If all goes well, people who use imagery as a mnemonic technique will remember more words than the control group.